P. SWARAJYA LAKSHMI* & T. PULLAIAH*: **Embryology of *Crassocephalum crepidioides* S. Moore**

P.S. ラクシュミ*・T. プライア*: ベニバナボロギクの胚学的研究

Embryology of the family Asteraceae is extensive and has been reviewed by Pullaiah (1984). A perusal of the literature reveals that embryology of *Crassocephalum crepidioides* (Benth.) S. Moore has not been studied but for a brief report on the development of embryo sac by Afzelius (1924). Hence the present investigation was undertaken to give a detailed description regarding male and female gametophytes formation, fertilisation, endosperm and embryo development.

Material and methods The material was collected from Kallar (foot hills of Nilgiris) by T. Pullaiah. Buds, flowers and fruits at different stages were fixed in formalin-acetic-alcohol (F. A. A.). Dehydration, embedding and sectioning were done by the customary methods. Sections cut at a thickness of 5–9 μm were stained in Delafield's haematoxylin. Voucher specimens were deposited in the Herbarium of Botany Department, S.K. University, Anantapur.

Observations Microsporangium, microsporogenesis and male gametophyte. The anthers are bisporangiate (Fig. 1A). The male archesporium is hypodermal and consists of a single row of 5–6 cells in each lobe (Fig. 1B). The archesporial cells divide periclinally to form the primary parietal layer and a primary sporogenous layer (Fig. 1C). The primary parietal layer undergoes further periclinal and anticlinal divisions and produce three wall layers—the hypodermal layer, the middle layer and the tapetum (Fig. 1D). The epidermal cells persist at maturity as flattened cells. The hypodermal layer differentiates into fibrous endothecium (Fig. 1F). The middle layer is ephemeral. Tapetum is periplasmodial (Fig. 1E). Tapetal cells become binucleate (Fig. 1G). Later on due to nuclear divisions and fusions multinucleate and polyploid cells are formed (Fig. 1H, I). At one-nucleate pollen grain stage, the walls of the tapetal cells break down and the cytoplasm flows into the anther locule forming periplasmodium (Fig. 1E). The life of periplasmodium is very short.

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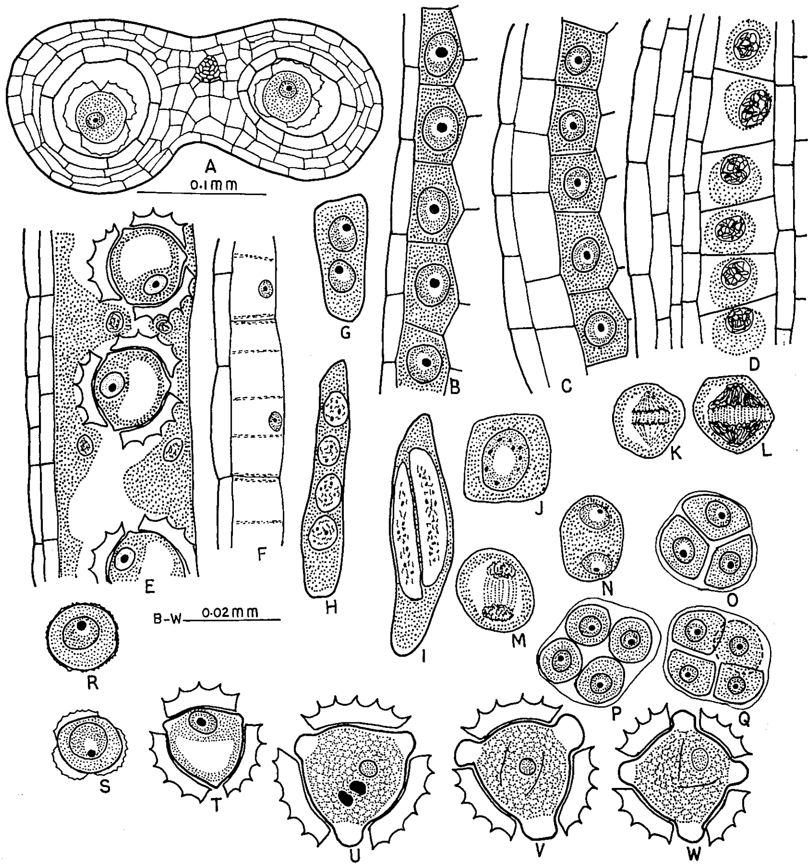

Fig. 1. *Crassocephalum crepidioides*. A. Transverse section of bisporangiate anther. B–D. Longitudinal section of part of anther lobes showing wall development. E. Longitudinal section of part of anther lobe showing periplasmodium. F. Fibrous endothecium. G–I. Anther tapetal cells. J–N. Pollen mother cells in meiosis. O–Q. Tetrahedral, isobilateral and decussate microspore tetrads respectively. R–T. Uninucleate pollen grains. U–W. Three-celled pollen grains.

The sporogenous cells undergo divisions forming a single row of pollen mother cells. The pollen mother cells undergo meiosis resulting in tetrahedral, isobilateral and decussate microspore tetrads (Fig. 1J, Q). Cytokinesis is of the simultaneous type. The pollen grain after its release from the tetrad enlarges and gradually develops its own wall (Fig. 1R–T). The pollen grains

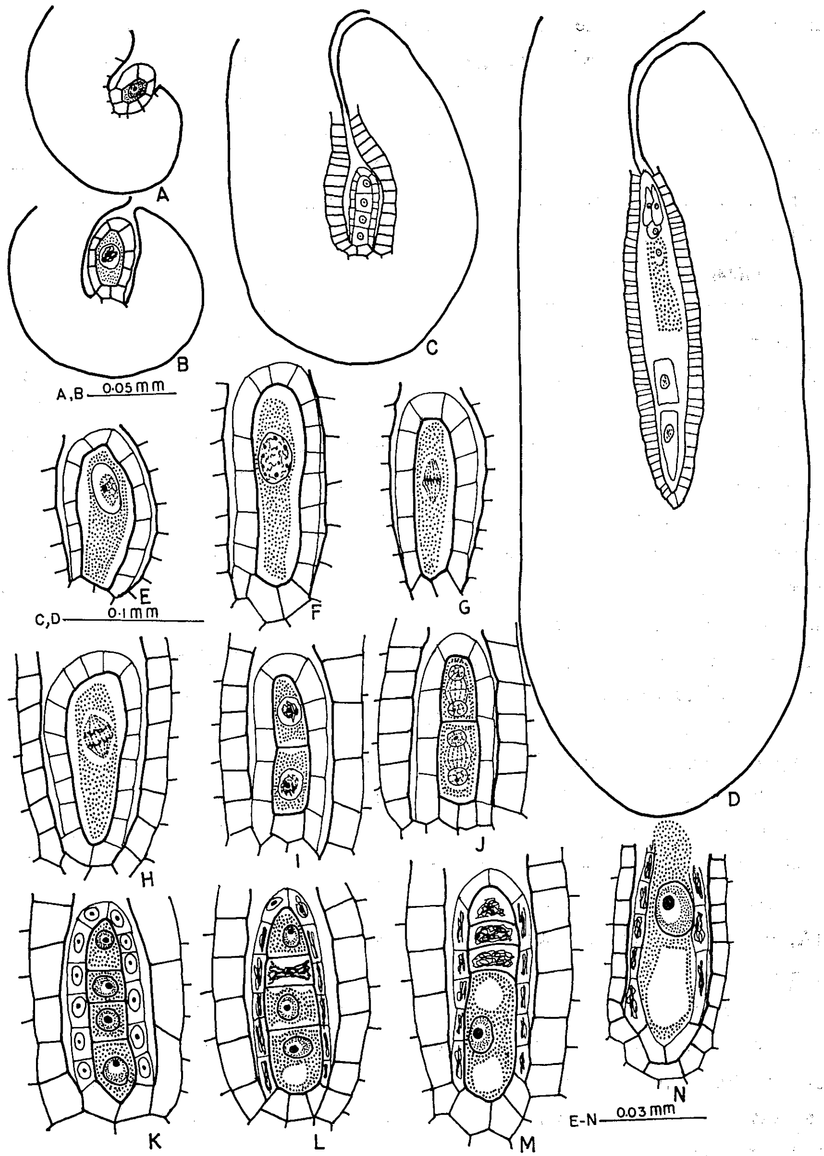

Fig. 2. *Crassocephalum crepidioides*. A-D. Stages in the development of ovule. E-H. Megaspore mother cell showing meiosis I. I. Megaspore dyad. J. Meiosis II. K. Megaspore tetrad. L, M. Megaspore tetrads showing degenerating megaspores. N. Uninucleate embryo sac.

are three-celled at the shedding stage with three germ pores (Fig. 1U, V). Rarely, pollen grains with four germ pores are also noticed (Fig. 1W).

Ovary and ovule. Ovary is inferior, bicarpellary, syncarpous and unilocular with a single basal, anatrpous, unitegmic and tenuinucellate ovule (Fig. 2A-D). Endothelium is distinct by the time the megaspore tetrad is formed (Fig. 2H-K). It remains uniseriate with uninucleate cells throughout its further growth (Fig. 3F) till it is completely absorbed by the growing embryo.

Megasporogenesis and female gametophyte. An archesporial cell which was differentiated below the nucellar epidermis (Fig. 2A) functions directly as megaspore mother cell (Fig. 2B, E). The megaspore mother cell undergoes meiotic divisions to produce a linear tetrad of megaspores (Fig. 2E-K). The micropylar three megaspores degenerate and the chalazal megaspore becomes functional (Fig. 2L, M) which pierces the nucellar epidermis and protrudes out side (Fig. 2N). The nucleus undergoes three mitotic divisions and produces an eight-nucleate embryo sac of the Polygonum type (Fig. 3A-F). The two polar nuclei unite near the egg apparatus resulting in secondary nucleus which lies near the egg apparatus. The synergids are hooked (Fig. 3F). Antipodals, which are either 2 or 3 in number, show nuclear divisions and fusions resulting in multinucleate and polyploid condition (Fig. 3G-K). Antipodals persist up to the time of cotyledon initiation of the embryo (Fig. 4B).

Fertilisation, endosperm and embryo. The entry of pollen tube is porogamous. Syngamy and triple fusion occur more or less simultaneously (Fig. 3L).

The endosperm development is *ab initio* cellular. The primary endosperm nucleus divides much earlier than the zygote and is followed by cytokinesis. The two cells so formed divide vertically forming four cells. Further divisions in these cells occur in all planes resulting in a massive cellular tissue (Fig. 4A, B). The endosperm but for one or two layers of cells is completely consumed by the growing embryo.

The zygote undergoes transverse division resulting in two-celled proembryo (Fig. 4C, D). The basal cell *cb* divides earlier than the cell *ca* resulting in a 3-celled linear proembryo (Fig. 4E). The terminal cell *ca* undergoes two vertical divisions at right angles to one another forming quadrants (Fig. 4F). Further divisions (Fig. 4G-M) are essentially similar to those investigated earlier. The development follows the Senecio variation of Asterad type of Johansen (1950) and Grand period I, Megarchetype II, series A, and subseries

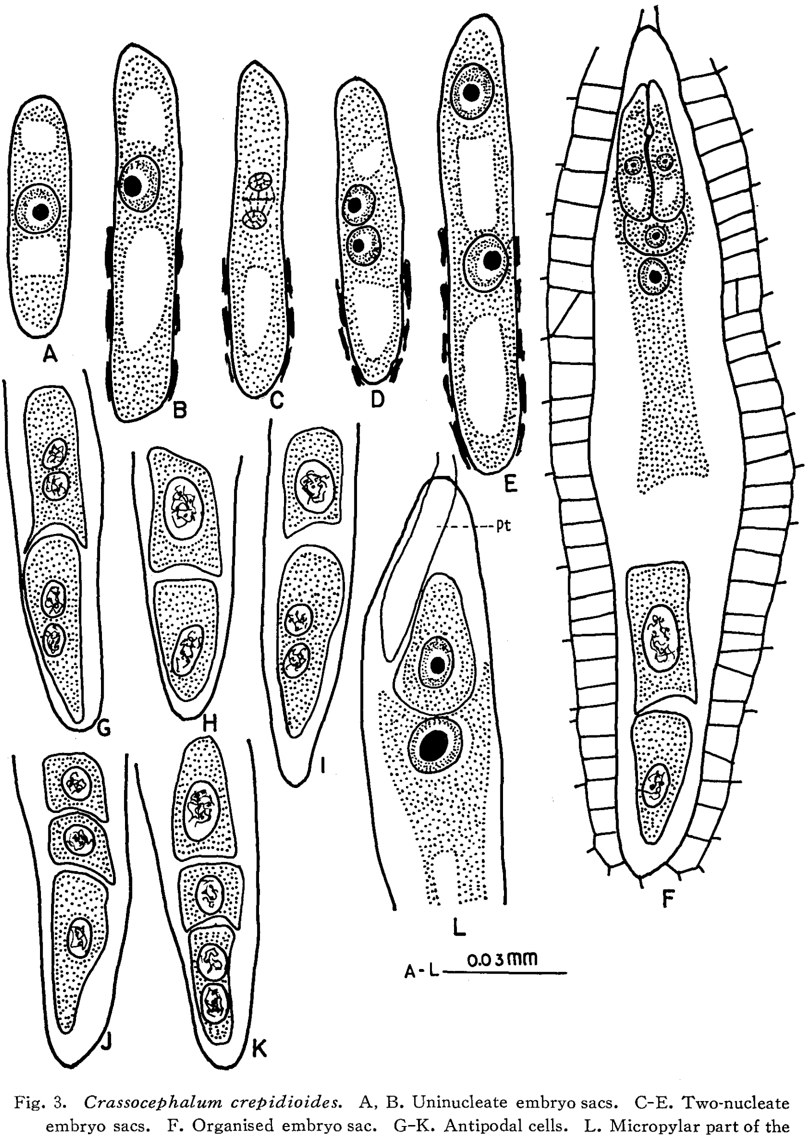

Fig. 3. *Crassocephalum crepidioides*. A, B. Uninucleate embryo sacs. C–E. Two-nucleate embryo sacs. F. Organised embryo sac. G–K. Antipodal cells. L. Micropylar part of the embryo sac showing zygote and primary endosperm nucleus. (pt, pollen tube).

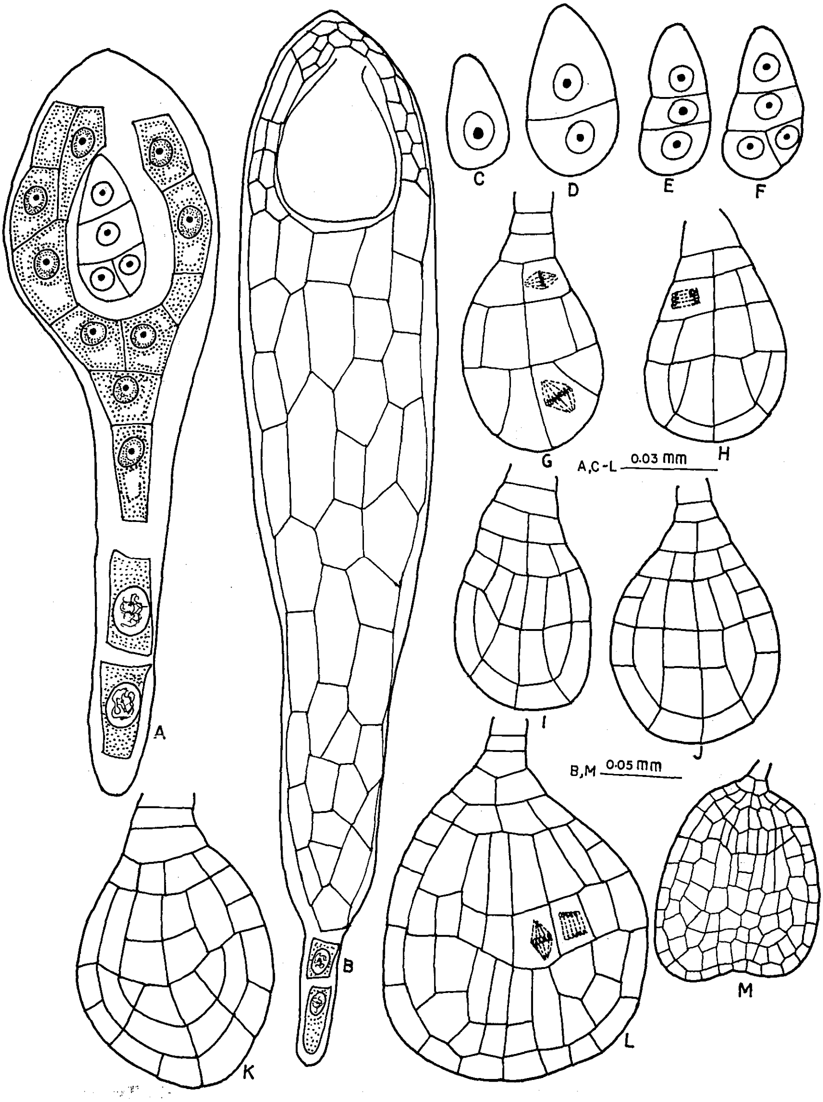

Fig. 4. *Crassocephalum crepidioides*. A, B. Stages in the development of endosperm. C–M. Depicts the development of embryo.

A_2 in the first embryonic group according to Souèges system (Crété 1963).

Discussion The taxon studied is in agreement with the earlier studies of the embryology of other representatives of the Senecionae. The anthers are tetrasporangiate in all the members studied so far except *Gynura nitida* (Pullaiah 1983) and *Crassocephalum crepidioides* (present study) where bisporangiate anthers are met with.

The present study shows the periplasmodial type of tapetum. But Prakasa Rao *et al* (1979) reported the occurrence of glandular tapetum in *Emilia flammea* which appears questionable because periplasmodial tapetum is a characteristic feature of the family Asteraceae (see Pullaiah 1984).

Majority of the species in the tribe show Polygonum type of embryo sac development. In the present investigation also Polygonum type of embryo sac development is met with which is in conformity with the report of Afzelius (1924).

Both cellular and nuclear types of endosperm development are met with in this tribe. The present species shows cellular type of endosperm development as in *Emilia flammea* (Litvinenko & Dzevaltovsky 1972) and *E. sonchifolia* (Pullaiah 1983) etc. Embryogeny follows the Senecio variation of Asterad type.

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ベニバナボロギクの花粉，大胞子，胚嚢，胚乳，胚の形成を研究した。花粉室のタペタム形成は periplasmoidal である。タペタム細胞は多核で polyploid である。花粉は3細胞期に放出される。胚珠は倒生で1層の珠皮を持ち，薄層珠心である。胚嚢形成は

タデ型。反足細胞は 2〜3 細胞からなり，各細胞は多核になり，授精後胚が球形に発達するまで残っている。胚乳形成は細胞型。胚形成はコンギク型である。これらは今迄に報告されたサワギク連のものと同じである。ただサワギク連のほとんどは葯が 4 室であるが，これは 2 室であり，サンシチソウ属のものに一致する。

□James A. Saunders, Lynn Kosak-Channing & Eric E. Conn (ed.): **Phytochemical effects of environmental compounds** (Recent advances in phytochemistry Vol. 21) 269 pp. 1987. Plenum Press, New York. 本書は 1986 年 7 月13日〜17日米国メリーランド州 College Park で催された第 26 回北米植物学会の講演をまとめたもので，環境物質が如何に植物の生理に影響するかを種々な角度から検討した研究を紹介している。すなわち，1）SO_2 と葉緑体の代謝，2）植物細胞膜へのオゾンの攻撃の生化学，3）オゾンと SO_2 の植物の生長と植物体中の炭素の配分に対する影響，4）Water Hyancinth によるフェノール性化合物の取り込みと代謝，5）植物プランクトンによる微量元素毒性の調節，6）植物および細菌チトクローム P-450 と除草剤の代謝，7）大気中の PCB の作物への蓄積，8）酸性雨雪と地上植物，9）重金属の生物学的利用率，などの各章に分けて記述されている。これらの内容は基礎的な植物学にも，また農学，環境衛生にも深く係わり合いを持ち，人間生活に重要な諸問題を提供している。

(柴田承二)

□Buck, W.B. (ed.): **Bryostephane Steereana** 778 pp. 1987. Mem. New York Bot. Garden, vol. 45. $138.40. 元 New York 植物園長でコケ類の研究者として有名な，Dr. W.C. Steere の80歳のお祝いとして出版された論文集である。目を引くのは，表紙に大きく印刷された Dr. Steere のフィールド・スタイルの笑顔写真と，この部厚な論文集のタイトルである。Bryostephane というのはギリシア語で“コケの冠”という意味である。この論文集には共著を含め84名の著者による68論文が収められていて，すべてが蘚苔類に関するオリジナル論文である。論文の内容によって，歴史（4編），形態・細胞（8編），生理・生態（4編），フローラ：北アメリカ（6編），古植物（2編），フローラ：熱帯アメリカ（9編），地理（3編），フローラ：オーストララシア・オセアニア・南極（24編），モノグラフ（8編）と分けられている。上記のように幅広い分野の論文が集まっているが，やはり分類学的取扱いのものが多く，蘚苔にわたり，Dr. Steere に献名された新種（6 種），新属（3 属）もある。巻頭を飾る Dr. Steere 夫人の “A letter from Dorothy” は異色で，Dr. Steere との 60 年間の生活をふりかえったエッセーで，興味深いものである。

(井上　浩)